SUMMER – 18 EXAMINATIONS

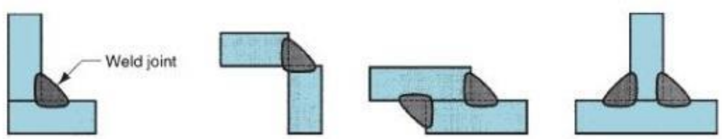
Subject Code: **17455** **Model Answer**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

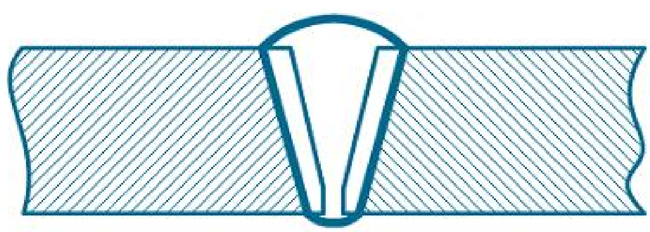
<table>
<tr><th>Q. NO.</th><th>MODEL ANSWER</th><th>MARKS</th><th>TOTAL</th></tr>
<tr><td>1.</td><td>Attempt any five of the following</td><td>5*4</td><td>20</td></tr>
<tr><td>a)</td><td>

1) Fillet weld



Fillet weld on corner joint   Fillet weld on lap joint   Fillet weld on T-joint

2) SINGLE V- BUTT

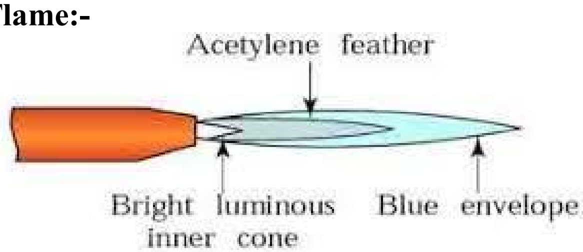


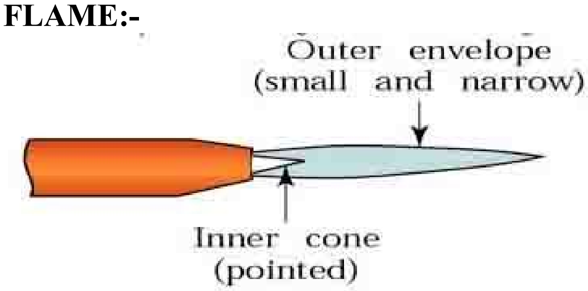
</td><td>2m for each DIA</td><td>04</td></tr>
<tr><td>b)</td><td>
<table>
<tr><th>Sr. no</th><th>AC power source</th><th>DC power source</th></tr>
<tr><td>1</td><td>A.C. welding machine is cheaper, small in size, light in weight and simple to operate.</td><td>D.C. welding machine is two to three times costlier, larger in size, heavier in weight and is more complicated.</td></tr>
<tr><td>2</td><td>Maintenance of A.C. welding machine is easier and more</td><td>Maintenance cost is higher because of many moving parts in</td></tr>
</table>
</td><td>1m for each point any 4 points</td><td>04</td></tr>
</table>

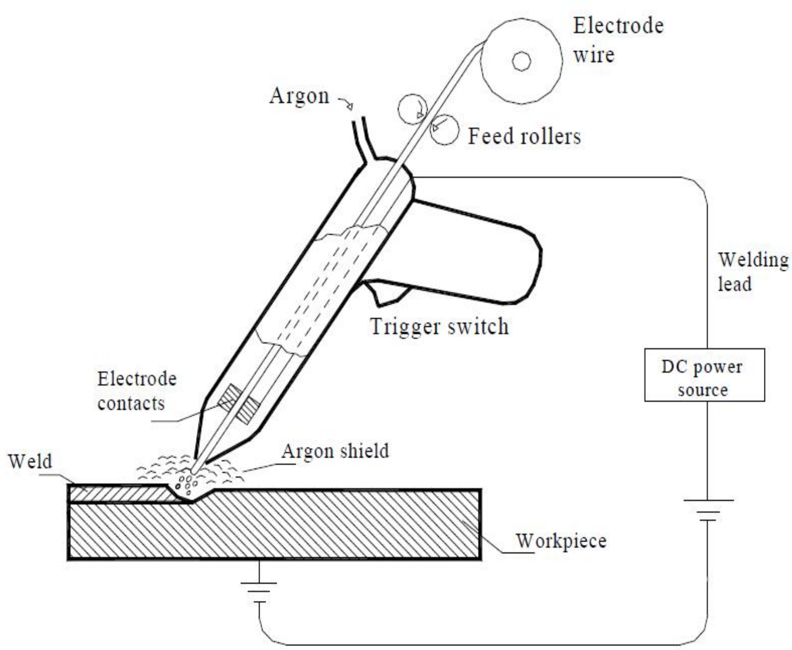
		economical, because there is no moving part in it.	it.	
	3	Heat generated is equal at both the poles, so it does not require changing of polarity.	Heat generated is different at the work and the electrode by changing the polarity.	
	4	A.C. welding machine is not suitable for welding all metals particularly non-ferrous metals and alloys.	D.C. welding machine is suitable for welding all types of metals by changing the polarity	
	5	Bare electrode cannot be used. Only specially designed coated electrodes can be used.	Both coated and bare electrode can be used in D.C. welding machine.	
	6	The problem of arc-blow can be easily controlled.	Arc-blow is severe and difficulty to control.	
	7	A.C. Welding machine has lower operating cost.	It has higher operating cost.	
	8	A.C. Welding machine has high efficiency (0.8 to 0.85).	Efficiency of D.C. Welding machine is low only 0.3 to 0.6.	

c)	**i) Straight Polarity:-** Electrode is connected with the negative terminal of the power source and base metals are connected with the positive terminal. Under sufficient potential difference, electrons liberate from the tip of the electrode and strike the base plate surface. Arc voltage and arc stability does not depend on work material emissivity. Inclusion defects may arise if base plate surfaces are not cleaned properly prior to the welding. **ii) Reverse Polarity:-** Base metals are connected with the negative terminal of the power source and electrode is connected with the positive terminal. Here electrons liberate from base plate surface and strike the electrode tip. 2/3rd of the total arc heat is generated at electrode tip and rest is generated near base plate. Due to good arc cleaning action, tendency of inclusion defects reduces.	2m 2m	**04**
d)	**Weldability:-** Weldability is the capacity of a material to be welded under the fabrication conditions imposed into a specific suitably designed structure and to perform satisfactorily in the intended service. **COMPARISION:-** The Weldability depends up on the carbon content less the percentage more will be its Weldability. Generally cast iron contains more amount of carbon	2m 2m expainati on	**04**

	than steel so the Weldability of iron is slightly les than to that of steel.		
e)	**HAZ:-** Adjacent to the weld metal zone is the heat-affected zone that is composed of parent metal that did not melt but was heated to a high enough temperature for a sufficient period that grain growth occurred. - Heat -affected zone is that portion of the base metal whose mechanical properties and microstructure have been altered by the heat of welding **Characteristics:-** HAZ usually contains a variety of microstructures. In plain carbon steels these structures may range from very narrow regions of hard martensitic t6 coarse pearlite. This renders HAZ, the weakest area in a weld. The HAZ in low carbon steel of normal structure welded in one run with coated electrodes or by submerged arc process comprises three metallurgical distinguished regions. 1. The grain growth region 2. The grain refined region,. 3. The transition region	2 m 2m	**04**
f)	During the selection of steels, the characteristics of the HAZ are more important than the weld metal. This is since the metallurgical and mechanical properties of the HAZ are directly linked to the selected steel. However, these properties can be adjusted by welding parameters and post weld heat treatment (PWHT). Also the metallurgical and/or Weldability issues related with the HAZ characteristics are more difficult to tackle than those connected with the weld metal. Welding issues which usually occur in the weld metal can frequently be overcome by changing the welding electrode and/or other welding consumables. In comparison, difficulties with the HAZ can often be resolved only by changing the base steel, which is generally a very costly measure, or by changing the heat input. Different empirical C equivalents (CE) have been developed and utilized to evaluate the Weldability and the tendency of hydrogen (H_2) induced cracking (HIC) of the base steels.	4 m	**04**

g)	PRINCIPLE OF BRAZING - Brazing involves the melting of a comparatively Iow melting point filler material against the base metal pieces to be joined while they are clean and free from oxides, oil, grease, etc. It is not necessary to melt the base metal. - The molten (brazing) filler material (i) Wets the base metal surfaces, (ii) Spreads along the joint (to be brazed) by capillary action, (iii) Adheres and solidifies to from the brazed joint. - Capillary flow plays a major role in producing good brazements, provided the base metal surfaces are wet by the molten filler material. The flux which is employed during brazing melts at a lower temperature than the brazing filler material, wets the surfaces to be brazed, removes the oxide film and gives clean surfaces. -Since the capillary attraction between the base metal and the filler material is at least several times higher than that between the base metal and the flux, the filler material replaces the flux and flows into the narrow space or joint between the surfaces by capillary attraction. - The narrower the joint the better will.be the capillary flow. -The joint (thus filled with liquid filler material) upon cooling to room temperature, will be found filled with solid filler material and the flux, now also solidified, will be found on the joint periphery.	04m	**04**
2.	**Attempt any FOUR of the following**	**4*4**	**16**
a)	**1) Carburizing Flame:-**  Figure 2: Carburizing Flame The **reducing flame** is the flame with low oxygen. It has a yellow or	01 m For each dia and 1 mark for each explainat ion	**04**

	yellowish color due to carbon or hydrocarbons which bind with (or *reduce*) the oxygen contained in the materials processed with the flame. The reducing flame is also called the **carburizing flame**, since it tends to introduce carbon into the molten metal. **2) OXIDISING FLAME:-**  **Figure3: Oxidizing Flame** If after the neutral flame has been established the supply of an oxidizing flame can be recognized by the small white cone which is shorter, much blue in colour & more painted than that of the neutral flame. This is because of excess oxygen & which causes the temperature to rise as high as 6300 F.		
b)	**Arc Stability:-** Arc is said to be stable if it is uniform and steady. A stable arc will produce good weld bead and a defect-free weld nugget. Defects commonly introduced by unstable arc slag entrapment, porosity, blow holes and lack of proper fusion. **Effect of stable arc on welding quality:-** -it is very much clear that if the arc is stable in nature then the quality of weld will be improved. -The weld appearance will get improved -The chances of weld defects will get reduced -Because of stable arc efficiency of welding will be excellent.	02 m 2M (any 2)	**4M**
c)	**Short-circuit Transfer** In short-circuit transfer; the electrode touches the work and short circuits, causing the metal to transfer as a result of the short. This happens at a rate of 20 to more than 200 times per second. The advantage of the short-circuit transfer is its low energy. This method is normally used on thin material ¼ inch or less, and for root passes on pipe	4m	**4m**

	with no backing. It can be used to weld in all positions. This mode of transfer generally calls for smaller-diameter electrodes, such as 0.023, 0.030, 0.035, 0.040, and 0.045 in. The welding current must be sufficient to melt the electrode, but if it is excessive, it can cause a violent separation of the shorted electrode, leading to excessive spatter. Using adjustable slope and inductance controls can enhance the transfer to minimize spatter and promote a flatter weld profile. Slope adjustment limits the short-circuit amperage, while inductance adjustments control the time it takes to reach maximum amperage. Proper adjustment of these two factors can produce excellent bead appearance and is essential for short-circuit transfer with stainless steel electrodes.		
d)	METEL INERT GAS (MIG):-  -It is an arc welding process wherein coalescence is roduced by heating the job with an electric arc established between a continuously fed metal electrode and the job. - No flux is used but the arc an-d molten metal are shielded byan inert as, which may be argon, helium, carbon dioxide or a gas mixture. -Before igniting the arc, gas and water flow is checked. Proper current and	2m dia & 2m explainat ion	**4m**

	wire feed speed is set and the electrical connections are ensured. -The arc is struck by anyone of the two methods. In the first method current and shielding gas flow is switched on and the electrode is scratched against the job as usual practice for striking the arc. -In the second method, electrode is made to touch the job, is retracted and then moved forward to carry out welding; but. before striking the arc, shielding gas, water and current is switched on.		
e)	**Following factors affecting solidification:-** 1) Temperature gradient: - If the temperature gradient is faster will be the solidification rate. 2) Growth rate: - If the growth rate of microstructure is more faster will be the solidification rate. 3) Undercooling: - if the undercooling rate is faster than solidification rate will be more. 4) Alloy composition: - the solidification rate is hampered by alloy composition.	1 m for each factor	**04**
f)	**Applications of Brazing:-** 1) Brazing is used for fastening of pipe fittings, tanks, carbide tips on tools, Radiators, heat exchangers, electrical parts, axles, etc. 2) It can join cast metals to wrought metals, dissimilar metals and also porous metal components. 3) It is used to join band saws, parts of bicycle such as frame and rims. 4) Metals having uneven thickness can be joined by brazing. 5) It is used for electrical components, pipe fittings.	1 m for each (any 4)	**04**
3.	**Attempt any <u>FOUR</u> of the following**	**4X4**	**16**
a)	**1) Welding Torch or Blow-pipe** - Oxygen and the fuel gas having been reduced in pressure by.the gas regulators are fed through suitable hoses to a welding torch which mixes and controls the flow of gases to the welding nozzle or tip where the gas mixture is burnt to produce a flame for carrying out gas welding operation. - There are two types of welding torches, namely: (i) High pressure (or equal pressure type. (ii) Low pressure (or injector) type	02m	**04**

	2) Oxygen and Acetylene Pressure Regulators - The pressure of the gases obtained from cylinders/generators is considerably higher than the gas pressure used to operate the welding torch. - The purpose of using a gas pressure regulator is, therefore (i) to reduce the high pressure of the gas in the cylinder to a suitable working pressure, and (ii) to produce a steady flow of gas under varying cylinder pressures pressure regulator is fitted with two pressure gauges. - A pressure regulator is connected between the cylinder/generator and the hose leading to welding torch.	02 m	
b)	The following factors influence the selection of a power source: 1. Available power (AC or DC, single phase, etc.). Where no power is available, a diesel engine driven DC generator may be used. 2. Available floor space. 3. Initial costs and running costs. 4. Location of operation (whether in the plant or in the field). 5. Personnel available for maintenance. 6. Versatility of equipment. 7. Required output. 8. Duty cycle. 9. Efficiency. 10. Type of electrodes to be used and metals to be welded, (e.g. non-ferrous materials and stainless steels are welded more effectively with DC than with AC). 11. Type of work	1m For each (any 4 factors)	**4m**
c)	TIG WELDING - TIG welding is the most commonly used method of welding aluminium	4m	**4m**

	today. Thinner gauges of aluminium can be joined without a filler metal. - TIG welding involves striking an arc between a tungsten (alloy) electrode and the workpiece to provide heat for joining. A separate filler rod is employed when welding thicker workpieces. TIG welding resembles gas welding because both employ a heat source independent of the filler (metal) electrode. -Gas welding employs a flux whereas TIG welding makes use of an inert gas to prevent any reaction between the molten weld metal and the atmosphere. Shielding Gas- - Argon is generally used for TlG welding aluminium. - Helium is sometimes employed with higher speeds and for thicker sections. - Mixtures of argon and helium are also used for welding aluminium where a balance of characteristics is desired		
d)	1)Causes of slag incIusions:- • Failure to remove slag • Entrapment of refractory oxides • Tungsten in the weld metal • Improper joint design • Oxide inclusions • Slag flooding ahead of the welding arc • Poor electrode manipulative technique • Entrapped pieces of electrode covering 2)Causes of incomplete fusion:- • Insufficient heat input, wrong type or size of electrode, improper joint design, or inadequate gas shielding • Incorrect electrode position	01m for any one reason of each	**04**

Weld metal running ahead of the arc
Trapped oxides or slag on weld groove or weld face

3) Caueseof Inadequate joint penetration:-

Excessively thick root face or insufficient root opening
Slag flooding ahead of welding arc
Electrode diameter too large
Misalignment of second side weld
Failure to backgouge when specified
Bridging of root opening

4) Causes of porosity:-

Excessive hydrogen,nitrogen, or oxygen in welding atmosphere
High solidification rate
Dirty base metal
Dirty filler wire
Improper arc length, welding
current, or electrode manipulation

<table>
<tr><td>e)</td><td>
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<tr><th>Sr.no.</th><th>Cold cracking</th><th>Hot cracking</th></tr>
<tr><td>1</td><td>Cold cracking occurs when three conditions are present: enough sensitive material involved, sufficient level of hydrogen, and a high level of residual stress.</td><td>Hot cracking is mainly due to high amounts of elements with low melting temperatures in the base material.</td></tr>
<tr><td>2</td><td>Cold cracking is limited to steels and is associated with the formation of martensite as the weld cools</td><td>Hot cracking, also known as solidification cracking, can occur with all metals</td></tr>
<tr><td>3</td><td>The cracking occurs in the heat-affected zone of the base material.</td><td>It happens in the fusion zone of a weld.</td></tr>
<tr><td>4</td><td>To reduce the amount of distortion and residual stresses, the amount of heat input should be limited, and the welding sequence used should not be from one end directly to the other, but rather in segments</td><td>To diminish the probability of this type of cracking, excess material restraint should be avoided, and a proper filler material should be utilized</td></tr>
</table>
</td><td>1m for each point</td><td>4m</td></tr>
<tr><td>f)</td><td>Limitations:-
High degree of skill is required
Limited size of parts
Delicate parts are required to be joined so more care need to be taken.
The strength of soldered joint is less.
Applications: Soldering is used for,
Sealing, as in automotive radiators or tin cans
Electrical Connections
Joining thermally sensitive components
Joining dissimilar metals
Drain water gutters and pipes.
Brass halved bearings.
Repairing of utensils.</td><td>2m Any 2

2m Any 2</td><td>4m</td></tr>
</table>

4.	**Attempt any <u>FOUR</u> of the following**	**4*4**	**16**
a)	**Rightward technique:-**	2m dia & 2m expainati on	**04**

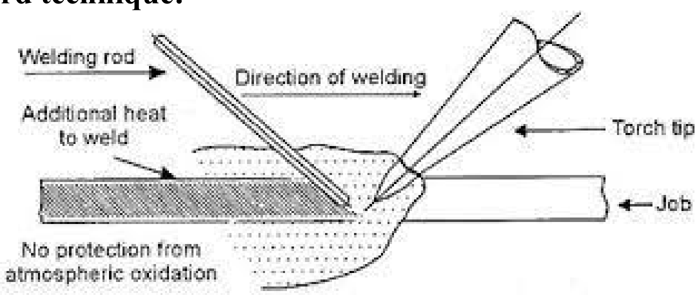
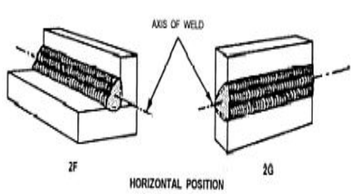
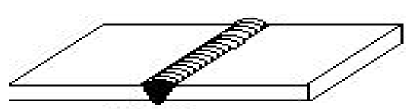
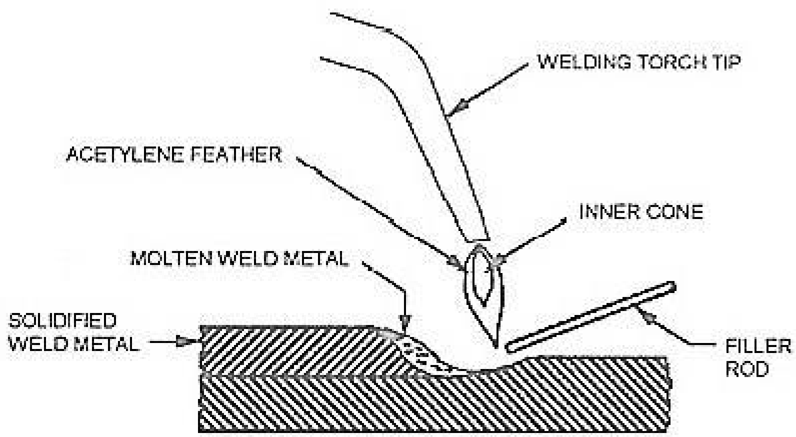


Fig. 5.3 Rightward (Backhand) Welding

Welder holds the welding torque in his right hand and filler rod in left hand.
The welding flame is directed towards the finished weld.
The head of the welding torque is held at an angle 40-50^0 from the plane of the weld.
The rightward technique is used in heavier or thicker base metals because in this technique the heat is concentered into the metal
The weld quality is better than obtained with leftward technique, also due to less consumption of filler rod the rightward technique involves lower cost of welding than leftward technique

b) — 1m for each point — **04**

Horizontal position	Flat Position
In the horizontal position, the weld's axis is the horizontal plane.	This type of welding is performed from the upper **side** of the joint
Horizontal position is a little easy to weld as compared to vertical position	The face of the weld is approximately horizontal
Horizontal welding is done in horizontal plane in horizontal weld axis	Flat welding is the preferred term; however, the same position is sometimes called downhand.
	 FLAT POSITION

c)	**OXY ACETYLENE WELDING** When acetylene is mixed with oxygen in correct proportions in the welding torch and ignited, the flame resulting at the tip of the torch is sufficiently hot to melt and join the parent metal.The type of filler rod used depends upon the mechanical properties required. A high tensile steel rod will be more effective, the weld metal must match with the parent metal. A flux is used to counteract the oxidation of alloying element After welding post heat treatment is necessary to refine the grain structure. The oxy-acetylene flame reaches a temperature of about 3200°C and thus can melt all commercial metals which, during welding, actually flow together to form a complete bond  	2m dia & 2m expainati on	**04**
d)	Processes for Welding Non-ferrous metal:- The following processes are employed for welding Non-ferrous metal are: (a) Metal Arc Welding (b) Oxy-acetylene Welding (c) Braze Welding (d) Brazing (e) Thermit Welding	Any one method explainat ion 4 m	**04**

(a) METAL-ARC WELDING OF Non-ferrous metal

Procedure

- A Veejoint with included angle of 60° to 90° may be formed (on the workpieccs to be joined) by chipping or machining.

Notching or studding may be adopted to increase the strength of the weld joint

- The joint is carefully cleaned of all dust, dirt, oil, grease and paint.

- Electrodes of cast iron, mild steel, austenitic stainless steel, nickel alloys etc., may be employed for welding cast iron.

- The arc is struck by touching the electrode with the job. As the molten pool forms, the welding is carried out in the normal way. In order to minimize the stresses set up in the workpiece, the welds may be laid in short runs (skip welding) and then each allowed to cool. Peening the weld while hot also relieves stresse.

OR

(b)OXY-ACETYLENE WELDING OF Non-ferrous metal

Introduction

- Cast iron is successfully welded by gas welding but it requires massive inputs of heat, both in preheating and during the welding operation.

-This large heat input may cause distortion or dimensional changes of the components.

T-he slower cooling rate resulting from gas welding, however, lessens the tendency for hardening of the heat affected zone.

-Joint Preparation

-A 60° to 90° Vee groove should be ground or chipped out or cut with a cutting torch or cutting electrode. This groove should not pass completely

	through the casting as otherwise alignment would be difficult. -For thin sections, a 75° to 90° Vee joint is generally used. For very heavy sections of25 mm and above, a 90° double- Vee joint is often recommended. -When welding can be made from one side only, the groove angle' should be increased to about 120 degrees. -When the groove extends through the casting, backing up with a graphite backing plate should be provided. -When repairing cracks, a hole should be drilled at each end of the crack prior to welding to prevent further propagation of the crack. Preheating the job - The job, before welding, is preheated at 620°C in a furnace and then covered with asbestos cloth, exposing only the cavity to be welded. -If a furnace is not available, the casting can be covered with asbestos cloth and locally heated by gas name. -Thin sections may be preheated locally, whereas heavy sections should be preheated in their entirety in a furnace. **OR** (c)BRAZE WELDING OF Non-ferrous metal - Braze welding is used for making field repairs. New castings are generaIly not repaired by braze welding because of poor colour match. - Joints preparation for braze welding of gray cast iron is same as used for gas welding. - Filler rod materials may be Naval brass Manganese bronze		

	Nickel bronze For better colour match, instead of naval brass or manganese-bronze welding rods, nickel-bronze welding rods are preferred. - Flux may be added manually by dipping filler rod's heated end into it or the filler rod itself may be flux covered. - Preheating is not necessary unless the casting is heavy or complicated, in which case preheating between 316 and 4000C is sufficient. - The use of a salt bath is best for cleaning any of the cast irons prior to braze welding. If a salt bath is not available then, ground groove surfaces of cast iron are heated with a slightly oxidizing flame to duII red colour, cooled and wire brushed. This removes graphitic smear from the groove surface. - Slightly oxidizing flame is used for braze welding gray cast iron. - After welding, the job should be covered with a thermal protection and allowed to cool slowly. **OR** (d)BRAZING OF Non-ferrous metal - Brazing of gray cast iron is done to repair casting defects where strength and colour match are not of primary importance. - Brazing of cast iron: (i) Requires special precleaning methods" to remove graphite from the surface of iron; because the presence of graphite on the cast iron surface would prevent wetting and adhesion of the brazing alloy. (ii) Is carried out at temperature as low as feasible, in order to avoid reduction in the strength of iron. - Filler rod. Most copper and copper-base alloys are not satisfactory for brazing cast iron because their high melting points may embrittle the cast		

	iron through copper penetration. -A 6% tin-bronze brazing rod, melting at about 925°C can be successfully employed for brazing gray cast iron. Silver-brazing alloys are frequently used as filler rods. A typical composition of such alloys is: Ag-44 to 46% Cu-14 to 16% Zn-14 to 18% Cd-23 to 25% Brazing temperature-620 to 760°C. Silver brazing rods containing nickel produce greater bond strengths. - Process. -Brazing is generally done with an oxyacetylene torch and a neutral or slightly carburizing flame. -Other methods such as furnace brazing, resistance brazing, induction brazing etc., are also commercially used for the production of small parts. -Preheating between 205 and 427°C before torch or induction brazing may produce better result. **OR** (e) THERMIT WELDING OF Non-ferrous metal - Heavy structures such as machinery basis or frames are therrnitwelded. - Since therrnit metal shrinks as much as cast iron, any weld longer than eight times the sectional thickness may develop minute hairline cracks. Thus the designer must make suitable allowances for contraction cooling.		
e)	**Causes of insufficient fusion:-** 1. Insufficient heat input, wrong type or size of electrode, improper joint design, or inadequate gas shielding. 2. Incorrect electrode position 3. Weld metal running ahead of the arc.	2m Any 2	**04**

	4. Trapped oxides or slag on weld groove or weld face. **Causes of Spatter** 1)Excessive arc current 2)Longer arcs 3) Damp electrodes 4)Electrode being coated with improper flux ingredients	2m Any 2	
f)	(see table below)	1m for each point	**4**

SR	BRAZING	SOLDERING
1	These are stronger than soldering but weaker than welding. These can be used to bear the load up to some extent	These are weakest joint out of three. Not meant to bear the load. Use to make electrical contacts generally.
2	It may go to 600°C in brazing	Temperature requirement is upto 450°C.
3	Work pieces are heated but below their melting point.	No need to heat the work pieces
4	May change in mechanical properties of joint but it is almost negli ible	No change in mechanical properties after joining
5	Cost involved and skill required are in between others two	Cost involved and skill requirements are very low.
6	No heat treatment is required after brazing.	No heat treatment is required

	7 | Preheating is desirable to make strong joint as brazing is carried out at relatively low temperature | Preheating of workpieces before soldering is good for making good quality joint.		
5.	**Attempt any FOUR of the following**	**4*4**	**16**
a)	Following filler metals are used:- 1) Ferrous metals:- 309L 2) Alloy Steel:- 316L 3) Copper:- 308L 4) Aluminum:- 308L	1 m each	**04**
b)	Example: E 307411 means (a) It is a solid extruded electrode. (b) Its covering contains appreciable amount of titania; a fluid slag. (c) It is all position electrode, (d) It can be operated on DCRP, DCSP or AC with a power source having, open circuit voltage 50 volts, (e) Weld metal tensile strength ranges between 410 and 510 N/rnm^2 and minimum yield stress is 330 Nzmm", (10 N/mm2 = 1.02 kgf/mrn^2). (f) Minimum percentage elongation of weld metal (in tension) is 20% of 5.65 v'SO and impact value of weld metal at 27°C is 4.8 kgf m (or 47 J). Where Sois the cross-section area of the specimen being tested	4m	**04**
c)	Processes for Welding Alloy Steel:- The following processes are employed for welding Alloy Steel are: (a) Metal Arc Welding (b) Oxy-acetylene Welding (c) Braze Welding (d) Brazing	**Any 1 method 4m**	**04**

(e) Thermit Welding

(a) METAL-ARC WELDING OF Alloy Steel

Procedure

- A Veejoint with included angle of 60° to 90° may be formed (on the workpieccs to be joined) by chipping or machining.

Notching or studding may be adopted to increase the strength of the weld joint

- The joint is carefully cleaned of all dust, dirt, oil, grease and paint.

- Electrodes of cast iron, mild steel, austenitic stainless steel, nickel alloys etc., may be employed for welding cast iron.

- The arc is struck by touching the electrode with the job. As the molten pool forms, the welding is carried out in the normal way. In order to minimize the stresses set up in the workpiece, the welds may be laid in short runs (skip welding) and then each allowed to cool. Peening the weld while hot also relieves stresse.

OR

(b)OXY-ACETYLENE WELDING OF Alloy Steel

Introduction

- Cast iron is successfully welded by gas welding but it requires massive inputs of heat, both in preheating and during the welding operation.

-This large heat input may cause distortion or dimensional changes of the components.

T-he slower cooling rate resulting from gas welding, however, lessens the tendency for hardening of the heat affected zone.

-Joint Preparation

-A 60° to 90° Vee groove should be ground or chipped out or cut with a cutting torch or cutting electrode. This groove should not pass completely through the casting as otherwise alignment would be difficult.

-For thin sections, a 75° to 90° Vee joint is generally used. For very heavy sections of25 mm and above, a 90° double- Vee joint is often recommended.

-When welding can be made from one side only, the groove angle' should be increased to about 120 degrees.

-When the groove extends through the casting, backing up with a graphite backing plate should be provided.

-When repairing cracks, a hole should be drilled at each end of the crack prior to welding to prevent further propagation of the crack.

Preheating the job

- The job, before welding, is preheated at 620°C in a furnace and then covered with asbestos cloth, exposing only the cavity to be welded.

-If a furnace is not available, the casting can be covered with asbestos cloth and locally heated by gas name.

-Thin sections may be preheated locally, whereas heavy sections should be preheated in their entirety in a furnace.

OR

(c)BRAZE WELDING OF Alloy Steel

- Braze welding is used for making field repairs. New castings are generaIly not repaired by braze welding because of poor colour match.

- Joints preparation for braze welding of gray cast iron is same as used for gas welding.

- Filler rod materials may be

Naval brass

Manganese bronze

Nickel bronze

For better colour match, instead of naval brass or manganese-bronze welding rods, nickel-bronze welding rods are preferred.

- Flux may be added manually by dipping filler rod's heated end into it or the filler rod itself may be flux covered.

- Preheating is not necessary unless the casting is heavy or complicated, in which case preheating between 316 and 4000C is sufficient.

- The use of a salt bath is best for cleaning any of the cast irons prior to braze welding. If a salt bath is not available then, ground groove surfaces of cast iron are heated with a slightly oxidizing flame to duII red colour, cooled and wire brushed. This removes graphitic smear from the groove surface.

- Slightly oxidizing flame is used for braze welding gray cast iron.

- After welding, the job should be covered with a thermal protection and allowed to cool slowly.

OR

(d)BRAZING OF Alloy Steel

- Brazing of gray cast iron is done to repair casting defects where strength and colour match are not of primary importance.

- Brazing of cast iron:

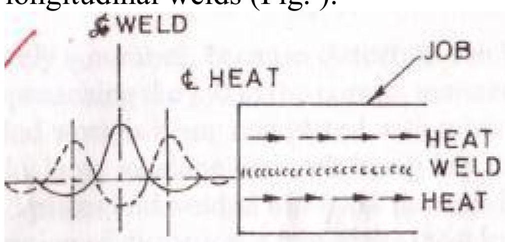
(i) Requires special precleaning methods" to remove graphite from the surface of iron; because the presence of graphite on the cast iron surface would prevent wetting and adhesion of the brazing alloy.

(ii) Is carried out at temperature as low as feasible, in order to avoid reduction in the strength of iron.

- Filler rod. Most copper and copper-base alloys are not satisfactory for

	brazing cast iron because their high melting points may embrittle the cast iron through copper penetration. -A 6% tin-bronze brazing rod, melting at about 925°C can be successfully employed for brazing gray cast iron. Silver-brazing alloys are frequently used as filler rods. A typical composition of such alloys is: Ag-44 to 46% Cu-14 to 16% Zn-14 to 18% Cd-23 to 25% Brazing temperature-620 to 760°C. Silver brazing rods containing nickel produce greater bond strengths. - Process. -Brazing is generally done with an oxyacetylene torch and a neutral or slightly carburizing flame. -Other methods such as furnace brazing, resistance brazing, induction brazing etc., are also commercially used for the production of small parts. -Preheating between 205 and 427°C before torch or induction brazing may produce better result. **OR** (e) THERMIT WELDING OF Alloy Steel - Heavy structures such as machinery basis or frames are therrnitwelded. - Since therrnit metal shrinks as much as cast iron, any weld longer than eight times the sectional thickness may develop minute hairline cracks. Thus the designer must make suitable allowances for contraction cooling.		
d)	1. Peening 2. Vibratory stress-relief 3. Thermal treatment 4. Thermo-mechanical treatment 5. Overstressing technique	2m each for any two procesees	**04**

	1**. Peening:** Peening has been employed with success for stress relieving purposes. When properly applied, peening causes plastic flow and subsequently relieves the restraint that set up in the residual stress. Peening reduces internal stresses of a very low intensity- far below any affected by heating below the critical point, because low temperature reduces only those internal stresses that are above the long-time yield point of the steel at the stress-relieving Peering also reduces distortion. Excessive peening should not be carried out as it may result in (i) cold working and strain hardening of the weld metal, (ii) bending, and (iii) cracking of the weld. - Peening should be employed only when the weld metal possesses sufficient ductility to undergo necessary deformation. 2. **Vibratory Stress-relief** - Welded structures (e.g., press frames) are subjected to vibrations to relieve residual stresses. - In this method of stress-relieving an oscillating or rotating wave generator is mechanically coupled to the part to be stress relieved. The welded structure is placed on a platform that vibrates and in turn, the welded structure vibrates at one of its natural (resonant) frequencies Since vibratory stress-relief treatment does not change the metallurgical structure of welds or heat -affected zone, it does not alter mechanical properties, i.e., the strength or toughness of the weldment 3. **,Thermal treatment** {Thermal treatment proves to better substitute than vibratory stress relief because it improves strength or toughness of the weldment by bringing changes in microstructures. - Thermal stress-relief treatment consists of heating a welded Structure uniformly to a suitable temperature (preferably in-a furnace) below the critical range of the parent metal, holding lt at this temperature for predetermined period of time, followed by uniform cooling. Still air is very desirable after the furnace is opened and until the structure is fully cooled. - A desirable thermal stress relieving treatment for a welded steel structure is heating uniformly to 595 to 650^{0}C, holding at that temperaturer-2hour per 25 mm of thickness and cooling slowly in the furnace to approximately 125°C and preferably lower. After treatment, the structure may be removed and allowed to cool to room temperature 595 to 650°C temperature is high enough to reduce the residual stresses rapidly; in addition, this relatively low temperature avoids undue distortion of the weldment. - The temperature used for stress-relief heat treatment may be in the range		

	of 525-740°C When lower temperature in the specified range is used, longer soaking times are necessary The residual stress remaining in a material after thermal stress relief will depend on the rate of cooling .The percentage relief of welding stresses is dependent on steel type, composition or yield strength 4. **Thermo-mechanical stress relief-treatment** - This technique aims at using thermal expansion to provide the mechanical forces required to set up another residual stress system to counteract and thereby cancel the original already set-up due to welding. - In this process two bands of heat (using two oxy-fuel gas torches moving in an e we are applied to either side of a longitudinal welds (Fig.).  Fig. Application of bands of heat. The positions of heat bands are chosen such that this way developed residual stresses counteract and cancel the original stresses set-up due to welding. - The metal on either side of a welded joint{s heated to a temperature of 175 to 205°C, while the weld itself is kept relatively cool. - Reductions in transverse residual stresses ranging up to 60%, as well as a considerable reduction in the longitudinal stresses, have been reported using thermo-rnechanical stress relief treatment. - Since this low-temperature treatment in most metals does not improve metallurgical properties of weld metal and heat affected zone, it is not considered as a good substitute for thermal stress relief treatment to provide ductility and notch toughness		
e)	Effect of welding on properties of metal - Welding involves many metallurgical phenomena. Welding ope- ration somewhat resembles to casting. - In all welding processes, except cold welding, heating and cooling 'are essential and integral parts of the process. High degrees of superheat in the weld metal may be obtained in many fusion welding processes. Heat affected zone 1. The grain growth region 2. The grain refined region, .	4m	**04**

	3. The transition region The grain growth region. - Grain growth region is immediately adjacent to the weld metal zone (fusion boundary). - In this zone parent metal has been heated to a temperature well above the upper critical (A3) temperature. This resulted in grain growth or coarsening of the structure. (b) The grain refined region - Adjacent to the grain growth region is the grain refined zone. - The refined zone indicates that in this region, the parent metal has been heated to just above the A 3 temperature where grain refinement is completed and the finest grain structure exists. (c) The Transition zone In the transition zone. a temperature range exists between the lower critical temperature and upper critical temperature transformation temperatures where partial allotropic recrystallization takes place (c) Unaffected Parent Metal - Outside the heat affected zone is the parent metal that was not heated sufficiently to change its microstructure.		
f)	The main differences between soft and hard solders are their respective melting temperatures and strengths. The hard solder typically incorporates a proportion of silver in its composition which suits it for joining air conditioning components where a long life in a vibrating environment is needed. Soft solder melts under 400F. Hard solder melts at 1300F to 1500F depending on the grade used. Soft soldering has less corrosion resistance but hard soldering has more corrosion resistance. Soft soldered components are impractical for dental use and hard soldered components are most suitable for dental use. when you do soldering and if proper ammount of heat and flux is not applied,then your soldering goes improper and becomes mechanically weak/weaker joint/poor joint/improperly melted solder because of lack of heat results in hard soldering. main reason of hard soldering is slow heating/melting of solder at soldering joint or may be because of doing soldering work in outside open area where air blowing reduce the temperature of soldering iron bit. Poor strength of joint and reduced flow of electrons in circuit.	4m	**04**

	Soft soldering is considered correct soldering as far as flow of electrons in circuit and good strength of joint.		
6.	**Attempt any four of the following**	**4*4**	**16**
a)	**Limitations**:- 1) Heavy sections cannot be joined economically 2) Flame temperature is less than that of the temperature of the arc 3) Fumes produced during welding are irritating to the eyes, nose, throat and lungs. 4) Refractory metals and reactive metals cannot be joined 5) More safety problems arise. 6. Prolonged heating of the joint in gas welding results a larger heat-affected area. This often leads increased grain growth, more distortion and, in some cases, loss of corrosion resistance. 7. Acetylene and oxygen gases are rather expensive. **Application:-** 1)For joining most ferrous and non-ferrous metals, carbon steels, alloy steels, cast iron, aluminum and its alloys, nickel, magnesium, copper and its alloys, etc. 2. For joining thin metals. 3. For joining metals in automotive and aircraft industries. 4. For joining metals in sheet metal fabricating plants. 5. For joining materials those requires relatively slow rate of heating and cooling, etc.	02 marks (any two) 02 marks (any two)	**04**
b)	**Coating Of Electrode:-** The choice of electrode for SMAW depends on a number of factors, including the weld material, welding position and the desired weld properties. The electrode is coated in a metal mixture called flux, which gives off gases as it decomposes to prevent weld contamination, introduces deoxidizers to purify the weld, causes weld-protecting slag to form, improves the arc stability, and provides alloying elements to improve the weld quality. **Purpose:-** To prevent weld contamination Introduces deoxidizers to purify the weld, causes weld-protecting slag to form.	1m 2m any 2	**04**

	Improves the arc stability Provides alloying elements to improve the weld quality. **Coating Ingredients:-** Calcium Fluoride Cellulose Iron Powder Rutile	1m any 1	
c)	**CARE AND STORAGE OF ELECTRODE:-** **1.** Electrodes with damp coating will produce porosity and cracks in the joint electrodes with damage coating will produce joints of poor mechanically properties. **2.** In order to avoid the damage to the coating **3.** Electrode during storage should neither bend nor deflect **4.** Electrodes packets should not be thrown or pilled over each other **5.** Electrodes should be store in dry and well ventilated store rooms **6.** Before using the electrodes it may be dried as per the manufacture recommendation **7.** All electrodes especially the costlier one should be used. All they are left hardly 40-50mm **8.** Electrodes should be preferably retain in original packing for identification. Loss of identity of electrodes can waste lots of time in recognizing them properly.	4m Any 4 points	**04**

d)	• Resistance spot welding with controlled cooling, using up-slope and post-heating current (immediately after the weld time), to reduce the cooling rate and reduce the amount of martensite in the weld. • Resistance spot welding with in-process tempering where the weld time is followed by a cool time to allow the transformation to martensite. Further resistance heating during the temper time then tempers the martensite to reduce its hardness. • Resistance spot welding dissimilar materials (TRIP700 and DP600), to examine the influence of weld carbon reduction, i.e. reducing the carbon content of the weld nugget. • Weld growth curves were produced by pre-setting the electrode force and weld time, and then making welds at progressively increased current levels. The range of currents used was sufficient to define the limits of minimum weld size and weld splash. The minimum acceptable weld size was taken as 4 $\sqrt{t}$ (where t is the thickness in mm of the thinnest sheet in the combination). The effect of weld size on the cross-tension and shear strength of the weld was examined.	04 m (any 4 points)	**04**
e)	The various defects in welds are as follows with its remedies:- 1. Crack: Remedies:- • Minimize shrinkage stresses using backstep or block welding sequence • Change welding current and travel speed • Weld with covered electrode negative; butter the joint faces prior to welding. • Change to new electrode; bake electrodes to remove moisture • Reduce root opening; build up the edges with weld metal • Increase electrode size; raise welding current, reduce travel speed • Use filler metal low in sulfur • Change to balanced welding on both sides of joint • Fill crater before extinguishing the arc; use a welding current decay device when terminating the weld bead.	1 m for each remideis of each defect (any 4)	**04**

DISTORTION

Remedies :-

1) Use of jigs and fixtures, clamps, presetting, wedging and proper tacking may minimize distortion.

- Reducing the metal weld volume to avoid overfill and consider the use of intermittent welding
- Minimising the number of weld runs
- Positioning and balancing the welds correctly round the axis
- Using backstep or skip welding techniques, which involves laying short welds in the opposite direction
- Making allowance for shrinkage by pre-setting the parts to be welded out of position
- Planning the welding sequence to ensure that shrinkages are counteracted progressively
- Shortening the welding time

INCOMPLETE PENETRATION

Remedies:-

1) Electrode should be in the Centre of the joint.

- Follow correct welding procedure specification
- Maintain proper electrode position
- Reposition work, lower current, or increase weld travel speed
- Clean weld surface prior to welding

INCLUSIONS

Remedies:-

1) To prevent slag inclusions the slag should be cleaned from the weld bead between passes via grinding, wire brushing, or chipping.

2) This defect can only be repaired by grinding down or gouging out and re-welding.

POROSITY AND BLOW HOLES OR GAS POCKETS

Remedies:-

- Use low-hydrogen welding process; filler metals high in deoxidizers; increase shielding gas flow
- Use preheat or increase heat input
- Clean joint faces and adjacent surfaces
- Use specially cleaned and packaged filler wire, and store it in clean area

	• Change welding conditions and techniques • Use copper-silicon filler metal; reduce heat input • Use E60I0 electrodes and manipulate the arc heat to volatilize the zinc ahead of the molten weld pool • Use recommended procedures for baking and storing electrodes • Preheat the base metal • Use electrodes with basic slagging reactions POOR FUSION Remedies 1)Follow proper welding technique 2)Clean the weld metal from all oxides 3)The weld metal should be held properly before welding 4)Electrode diameter should be taken and held correctly POOR WELD BEAD APPEARANCE Remedies 1)Skilled workers are required 2)Proper arc length should be maintained 3)Good quality electrode and proper holding of electrode should be taken care. 4)Proper welding technique should be followed. SPATTER RemediesP:- Spatter can be minimized by correcting the welding conditions and should be eliminated by grinding when present. UNDER-CUITING Remedies:- Undercutting can be avoided with careful attention to detail during preparation of the weld and by improving the welding process. It can be repaired in most cases by welding up the resultant groove with a smaller electrode OVERLAPPING Remedies :- 1)The electrode diameter should not be too large to be manipulated conveniently and suitably		

	2)The base metal should be held properly 3)Proper arc length should be taken 4) The overlap can be repaired by grinding off excess weld metal and surface grinding smoothly to the base metal.		
f)	1. EFFECT OF GLASS STYLE ON SOLDER FATIGUE In many printed circuit boards (PCBs), the glass style plays a significant role on solder joint reliability. Often times, electronic design teams do not take into consideration the glass style for reliability analysis. Glass style, layer count and resin material determine the final coefficient of thermal expansion in the plane x-y directions. 2. EFFECTS OF COATINGS AND POTTINGS Coatings and pottings used in electronic assemblies for environmental protection of sensitive components in harsh use environments can often result in deleterious effects on solder joint fatigue. These effects originate from the polymer's coefficient of thermal expansion and elastic modulus interaction with temperature specifically around the glass transition temperature. 3. BOARD MOUNTING AND HOUSING Large board strains are generating around mounting point during thermal expansion of PCBs. Components which are placed within the vicinity of mounting points can be influenced by the excessive board strain and be susceptible to early failures during thermo mechanical fatigue conditions. 4. SOLDER ALLOY SELECTION FOR USE ENVIRONMENT With the current advancements in Pb-free solder alloy metallurgy, manufacturers of solder alloys offer a wide range of alloys for different application and manufacturing processes. The intended use of the electronic system should be considered in order to identify dominant failure mechanisms solder joints experience prior to the solder alloy selection step	1 m For each point	**04**

	of the design stage.		